1. Name of Experiment/Project/Collaboration: **LArIAT**
2. Physics Goals
    a. Primary: Physics R&D – Study of charge particle interaction mechanisms on Ar in the energy range of the production by SB and LB neutrino interactions.
    b. Secondary: Detector R&D – Study of new detector solutions, in particular for Scintillation Light read-out, in view of application in future large scale LArTPC experiments on both SB and LB neutrino beams.
3. Expected location of the experiment/project: Fermilab Test Beam Facility (FTBF), MCenter beam line, MC7 enclosure.
4. ~~Neutrino~~ source: low energy (0.2 – 2 GeV) charged particle beams
5. Primary detector technology: LArTPC + (new) enhanced Scintillation Light Detection System
6. Short description of the detector: 270-liter active LArTPC (2 wireplanes – U,V coordinates at 60^0 from horizontal axis, 4 mm pitch – 480 channels cold electronics read-out, CAEN V1740 digitization/DAQ) + Scintillation Light Read-Out (reflector & wavelength-shifter lining on field cage + PMT & SiPM array behind the wire planes – 50 PE/MeV expected light yield, for an enhanced light collection)
7. List key publications and/or archive entries describing the project/experiment: **LArIAT: Liquid Argon In A Testbeam –**

    arXiv:1406.5560 [physics.ins-det]

8. Collaboration
    a. Institution list: Argonne (US), Boston U. (US), Caltech (US), U. Chicago (US), U. Cincinnati (US), Fermilab (US), Imperial College London (UK), KEK (Japan), LANL (US), U. L'Aquila (Italy), LNGS-INFN (Italy), Louisiana State U. (US), Manchester U. (UK), Michigan State U. (US), U. Minnesota Duluth (US), U. Pittsburgh (US), Polish Academy of Sciences (Poland), Syracuse U. (US), U. Texas Arlington (US), U. Texas Austin (US), U. College London (UK), William and Mary Coll. (US), Yale U. (US)
    b. Number of present collaborators: about 70
    c. Number of collaborators needed.
9. R&D
    a. List the topics that will be investigated:
    i) experimental determination of the e to gamma-initiated shower separation;
    ii) development of criteria for charge sign determination without magnetic field;
    iii) single track calibration;
    iv) optimization of pion and kaon identification through their interaction modes in argon medium (direct measurement of pion and kaon interaction cross-sections);
    v) characterization of anti-proton stars in argon; and
    vi) energy resolution improvement by combination of the scintillation light signal to the ionization charge.
    b. Which of these are crucial to the experiment.
    c. Time line: **DAQ start-up expected at beginning (Jan-Feb) 2015**
    d. Benefit to future projects: A comprehensive characterization of LArTPC performance in the range of energies relevant to the forthcoming experiments of the SBN and LBN program. The beam in MC7 is the ideal place to perform this type of study, providing not only a range of

selectable known energies, but also a complete set of selectable types of different particles in both polarities. The test beam also provides a controlled environment in which to tune simulations and to validate the off-line software tools for PID, calorimetry, and event reconstruction without relying solely on simulation.

10. Primary physics goal expected results/sensitivity:
    a. For exclusion limit (such as sterile neutrino search), show 3-sigma and 5-sigma limits
    b. For discovery potential (such as the Mass Hierarchy), show 3-sigma and 5-sigma.
    c. For sensitivity plots, show 3-sigma and 5-sigma sensitivities
    (note that for neutrino-less double beta decay experiments that have previously been asked for 90% CL and 5 sigma limits these are OK)
    d. List the sources of systematic uncertainties included in the above, their magnitudes and the basis for these estimates.
    e. List other experiments that have similar physics goals
    f. Synergies with other experiments.
11. Secondary Physics Goal
    a. Expected results/sensitivity
    b. List other experiments that have similar physics goals
12. Experimental requirements
    a. Provide requirements (neutrino source, intensity, running time, location, space,…) for each physics goal
13. Expected Experiment/Project time line
    a. Design and development: 2012-2013
    b. Construction and Installation: 2014
    c. First data: Feb. 2015
    d. End of data taking: **First Run Feb.-July 2015, Second Run Oct. 15-July 16**
    e. Final results: 2016-17
14. Estimated cost range
    a. US contribution to the experiment/project
    b. International contribution to the experiment/project
    c. Operations cost
15. The Future
    a. Possible detector upgrades and their motivation: the detector size and configuration (front flange opening) allows for easy and quick installation of detectors inside the cryostat and their immediate characterization of performance in controlled and reproducible experimental conditions. Studies of different TPC schemes can be investigated (different wire spacing, wire orientation, angular dependence from electric field orientation) as well as of different electronics solutions (test of cold electronics prototypes and upgrade versions). A new solution for the scintillation light readout system is being tested in the first run, opening the way toward a more extended use of the light signal in LAr detector for neutrino physics. New different optical systems with enhanced collection efficiency are already under study/development for future tests in LArIAT. These include combinations of different wavelength-shifter materials, development of arrays of SiPMs, light collectors and light transport.

b. Potential avenues this project could open up: enhanced experimental sensitivity in neutrino oscillation studies (both with SB and LB neutrinos) from better/improved access to ultimate LAr detector performance and systematics control stemming from direct measurements and PID methods with beams of particles of known type and energy.
Development of detector technology and investigation primarily in new solutions for enhanced scintillation light detection and its combination with charge information toward a more complete event reconstruction and physics studies.